Article

An East Asian Link Model and Simulation Analysis

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Summary

In this paper we construted an East Asian econometric link model with forward looking variables and performed several simulations to analyze mainly how the change in the foreign exchange regime and FTA work The model consists of 11 countries including China, Japan, Korea, Taiwan, the US and several other Asian countries. Each country model has about 40-50 equations. The largest part of the model involves bi-lateral trade functions, which are necessarily required to link nations. In addition, it treats the capital flow as a part of investment functions.

In this study, it became clear that appreciation of yen will cause the large reduction of export and increase in expansion of Asian economies. Appreciation of yuan also leads expansion on the economy of other countries as well, however, China has much more effects on the Asian countries than Japan. According to the analysis of FTA, intra trade within ASEAN and China will grow greatly by concluding agreements. However, the effects will remain rather small outside the area, and will be limited to some extent. Fiscal expansion of Japan has a great influence on the other Asian countries, on the contrary, that of China tends to be restricted within China.

Keywords: Asian link model, forward looking, simulation, appreciation of yuan, bilateral trade

1. Introduction

Asian economy has decreased greatly due to the east Asian currency and financial crisis in 1997 excluding China and Taiwan. However, the Asian economic conditions have recovered comparatively in a short time afterwards and well maintained today in general. Whereas, Japan has grown only by 1% or less for the same period. Needless to say, Japan is surpassingly the largest economic nation in Asia; its nominal GDP almost amounts to 4 trillion dollars (2002), that is 4 times larger than taht of China and 8 times larger than that of Korea. Though the per capita income of most Asian countries is still low, the "economic vitality" in those nations is extremely high. Especially, the importance of Chinese economy has much grown that has led the economic structure from the two country relation limited within the US and Japan to multi country relation among the US, Japan and Asian countries.

Many econometric models analyzing inter-depending relations among these countries have been already developed, MULTIMOD by IMF is the most famous example (IMF, Laxton (1998)). Another important example is the East Asian link

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model by the Cabinet Office of Japan (Ban et. al., Cabinet Office (2002, 2000)). In addition, computer aided simulation model like McKibbin-Sacks Global Model (MSG) (McKibbin and Sacks (1988)) is also developed and utilized to analyze many aspects such as environmental problems and game theoretic policy simulations, and Kinoshita (2002) has developed many East Asian country models and trade linkage models.

This model focuses on several points as are shown below, which are common to many models now. In the first place, it handles the international capital flow. It is needless to say that a short-term speculative capital flow and the control of exchange rate have the decisive roles, which was seen in the East Asian Crisis in 1997. However, It is considerably difficult to treat a short-term fluctuation by the annual macro econometric model. Here, we examine how the capital flow such as the direct investment affects Asian economy through the investment and production in a mid term and long term.

The second is to handle the two country trade structures. For example, the US took the place of Japan now who was the largest exporting partner of China. The growth rate of Asian intra trade within those countries exceeds almost 10% annual averages for over 10 years, and the share of the intra trade has expanded very much. Thus, it should be noted that the analysis would be insufficient if only total import/export is taken into account conventionally because the expansion of the economic "bloc making" and FTA are actively observed in ASEAN countries. An export oriented economic structure in the East Asian nations should change widely if the mid/long-term exchange rate regime has changed as well as a change in a short-term capital flow and exchange rate. One of most important subjects is how the pressure to appreciate yuan would realize. This will change the relations among Japan, China, and the United States etc. , and exert a large influence on the world economy.

In the third, this model handles the expectation or forecasting. For example, it is clear that the expectation of the exchange rate or the stock price will influence a present decision making in the short-run. However, the importance of the expectation can be applied not only to the short term forecast but to the long term function, for example, the consumptions in the future will be affected by the forecast on the future income. A consumption function specified by permanent income hypothesis is the typical example in which the expectation exerts the great influence on the consumer behaviors. It is necessary to construct the forward looking model to introduce such a characteristic. Through this type of the model, changes which should be expected to occur in the future can be treated endogenously.

2. Estimation and solving method of a forward looking model

In this section, we briefly review the methodology of estimating models with the forward looking variables and how to solve the model.

(1) Adaptive expectation and rational expectation

The forward looking model which is commonly used today deals with the expectation explicitly, however, it is sometimes forgotten that the conventional models also deal with the expectations such as adaptive expectation. In the first place, we examine the relation between auto regressive formulation of the structural equations commonly used and the expectation.

First of all, consider the following theoretical model. Here, y and x are the endogenous and exogenous variables respectively. u is the error term and e denotes the expectation. This model has a characteristic that the expectation for the 1 period forward expectation of exogenous variables determine the present endogenous variables and the expectation of the exogenous conditions can be expressed to have the distributed lag structures.

$$y_t=\alpha+\beta x^e_{t+1}+u_t$$
$$x^e_{t+1}=\sum_{i=0}^{\infty}\beta_i x_{t-1}$$
$$\text{where, } \beta_i=\beta_0\lambda^i,\ 0<\lambda<1$$

By substituting the lag structures iteratively and taking the difference, we obtain the following equations.

$$x^e_{t+1}=\sum(1-\lambda)\lambda^i x_{t-1}$$
$$x^e_{t+1}-x^e_t=(1-\lambda)(x_{t+1}-x^e_t)$$

Through the assumption and transformations, unknown future variables can be substituted to the actual variables, and as the result, the expectation can be denoted as the following form.

$$\begin{aligned} y_t-\lambda y_{t-1}&=\alpha(1-\lambda)+\beta(x^e_{t+1}-\lambda x^e_t)+u_t-\lambda u_{t-1}\\ &=\alpha(1-\lambda)+\beta(1-\lambda)x_t+\upsilon_t \end{aligned}$$

This is the typical formulation of the adaptive expectation and we easily find that the formulation is quite the same as the conventional auto regressive models.

$$y_t=\alpha'+\beta' x_t+\gamma' y_{t-1}+\upsilon_t$$
$$\upsilon_t=u_t-\lambda u_{t-1}$$

Therefore, it is understood that the conventional model includes the adaptive expectation implicitly.

Next, we explain the model with the forward looking variables along with the explanation in Ban (1991) which is also dealt in Asian Link Model.

Though there may be several mechanisms to form the expectations, we define the expectation as the model consistent expectation, in which the model uses the expected values as the forward looking variables that have the minimum forecasting error and are estimated through the given model. (Maddala(1988)). To avoid the confusions with

the rational expectation theory, we often call this the model consistent expectations. However, here we use the conventional usage such as the rational expectation.

Consider the following rational expectation model. In this model, the present endogenous variables are affected by the future forecasts of those endogenous variables.

$$y_t = \beta y^*_{t+1} + \gamma x_t + \eta_t$$

Given the information set of the endogenous variables in advance, the expectation is identical with the mathematical expectation of the subjective one.

$$\begin{aligned} y^*_{t+1} &= E(y_{t+1} \mid I_{t-1}) \\ &= E(y^*_{t+1} \mid I_{t-1}) \end{aligned}$$

By staggering the period forwardly and by substituting the equations iteratively, we have the following equations.

$$\begin{aligned} &y_{t+1} = \beta y^*_{t+2} + \gamma x_{t+1} + \eta_{t+1} \\ &Ey_{t+1} = \beta Ey^*_{t+2} + \gamma Ex_{t+1} + E\eta_{t+1} \\ &\quad \text{where, } E\eta_{t+1} = 0 \\ &y^*_{t+1} = \beta y^*_{t+2} + \gamma x^*_{t+1} \end{aligned}$$

and then we have

$$y_t = \beta^n y^*_{t+n} + \gamma\beta^{n-1} x^*_{t+n-1} + \cdots + \gamma\beta x^*_{t+1} + \gamma x_t + \eta_t$$

If $\beta^n \to 0, n \to \infty$, then the equation above can be developed as the combination of expected exogenous variables and the present value.

$$y_t = \gamma\beta^{n-1} x^*_{t+n-1} + \cdots + \gamma\beta x^*_{t+1} + \gamma x_t + \eta_t$$

These results suggest that changes in the exogenous condition by anticipating policy changes in the future include a mechanism of changing the endogenous variables today. By these models, it becomes possible to evaluate the effects which could be diminished by anticipating the change in the future, and are empirically rather smaller than the case in using the conventional model.

On the other hand, it may raise a problem how to deal with the mechanism of forming the expectation of the exogenous conditions. At first, we substitute the expectation of the exogenous variables to the actual values, and also suppose that exogenous variables have lag structures.

$$x_t = \rho x_{t-1} + \nu_t$$

Now, let $x_t = Ex^*_t$

$$x^*_{t+1} = \rho x^*_t = \rho^2 x_{t-1}$$

Therefore, we rewrite the equation above as following,

$$y_t = \gamma(\beta^{n-1} x^*_{t+n-1} + \cdots + \beta x^*_{t+1}) + \gamma x_t + \eta_t$$

$$= \frac{\gamma\rho^2\beta}{1-\rho\beta}x_{t-1} + \gamma x_t + \eta_t$$

In this case, the model does not include the forecast of the future any more, and equivalent to the adaptive expectation model.

(2) Estimation of parameters with expectations

The conventional OLS method can not be applied for the case in which the error terms are serially correlated and complicated like the model with forward looking variables. In estimating the parameters with those variables, we usually apply Generalized Method of Moments (GMM) which was proposed by Hansen et. al..

Now, let W denote the matrix that consists of both endogenous and exogenous variables, then, a single equation is written as

$$y = W\beta + u$$

To avoid the correlation between explanatory variables and error terms, we usually apply the instrumental variables method. Let Z be the instrumental variable matrix and transform the equation above, then, we have the following expression for the estimators.

$$Z'y = Z'W\beta + Z'u$$
$$\beta_{INST} = \left(W'Z(Z'Z)^{-1}Z'W\right)^{-1}W'Z(Z'Z)^{-1}Z'y$$

However, in the case of parameters with a forward looking variable, we should consider the autocorrelation in the error term. Even if we assume the AR(1) process in the error term, it can not be resolved and parameters do not have consistency. Then, suppose

$$E(Z'uu'Z) \neq \sigma^2 Z'Z.$$

Using residual matrix, we calculate the GMM estimators which are consistent under the general condition.

$$e = y - W\beta_{INST}$$
$$V = Z'ee'Z$$
$$\beta_{GMM} = \left(W'ZV^{-1}Z'W\right)^{-1}W'ZV^{-1}Z'y$$

Here, to avoid the singularity of the inverse matrix V^{-1}, several methods including the weight matrix called Kernel have been developed.

(3) How to solve the forward looking models

It seems to be difficult to solve the model with forward looking variables because the future values should be prepared to estimate and calculate the present values. To solve

the model with the expectation, the Fair-Taylor iterative method has been developed (Fair (1984) (1994)) and this is implemented in several econometric applications today. This type of iterative method is as followings,

1) solving the model for the period (s) using conventional final test.
   As the model has the maximum lead time (h), period for solution is (s+h)------ TYPE (1)
2) substituting these forecast values to the temporary expectation, iterate procedures until the model has converged. If converged, the model solutions are equivalent to the expectation. ----- TYPE(2)
3) this solution depends on the value initially assigned, thus, usually does not satisfy the terminal conditions. In the Fair-Taylor method, the terminal condition is satisfied by achieving the certain constant value which is obtained through the iterative procedure to be extended to enough length (k). Furthermore, this procedure has the lead time (h).----- TYPE(3)

Finally, Fair-Taylor methods need to solve the model for a long period s+h+k+h, in which a vast number of calculation should be carried. Though the method has the poor ability to converge, if converged, that would be treated as the terminal values which are independent from the time. In this paper, we adopt this method.

Recently, new method called L-B-J was developed, which is one of the time stacking methods, and it is well converged. (Julliard and others (1998)).

3. The structure of the East Asian Link Model

(1) Overview

The East Asian Link Model proposed here is the annual econometric model which consists of 11 countries listed in the table below, and deals with bi-lateral trade models to link these countries. Each country model has 40-50 equations including identities, which consist of macro functions and trade functions. Total number of endogenous variables is about 500.

In this paper, explanation of the results is just limited to several countries such as Japan, the US, China, Korea and Taiwan, whose economies are relatively large in terms of GDP.

Asian countries excluding Korea, Taiwan, Hong Kong and Singapore belong to the developing countries whose per capita GNI or GDP do not exceed 5000 US$. We tried to apply the same type of structural equation to each country models, however, as to the investment function, for example, the role of foreign investment is quite different between developed and developing countries, so, investment function could be different. Formulation and characteristics of each equation suitable for the developing countries are well summarized in Chinna (2003).

Though each country model includes the forward looking variables, specifications

that include the expectation are rather limited to the specific functions such as consumption function, partly used in the specification for the interest rates. The expectations can be applied to specify the investment function as well as the consumption function. Although a good example is Asian Link Model developed by the Cabinet of Japanese Government, it seems to be difficult to calculate and estimate the corporate values here.

The method to estimate parameters is GMM in the case which includes the forward looking variables, and is conventional OLS basically if the equation does not include expectations. Sample period is from 1985 to 2002 (annual data). Some parameters such as price elasticity of export functions do not satisfy the sign condition, and have been calibrated using arbitrary values.

The most part of data used here is quoted from OEF (Oxford Economic Forecasting) database. There are some variables like capital stock and compensation of employee which are estimated by OEF, the rest for the most part are basically identical to the data published by IFS (IMF), WDI (World Bank). Trade data are from UN COMTRADE, DOT (IMF) and International Trade Data (OECD). Several equations which are intrinsically to be specified by identities are estimated to absorb the differences in the coverage of definition and units.

Finally, here are the rule of notations;

CH_GDP ：real GDP of China in Local Currency Unit
CH_GDPV ：nominal GDP of China, attached V denotes 'nominal'
CH_GDP$V ：nominal GDP of China in Dollar, $ denotes 'US dollar'
XX_CHJP$ ：bilateral trade between CH and JP in Dollar
GDP(-1) : 1-year lag
GDP(+1) : 1-year lead, this denotes Forward Looking variable
C(1), C(2) : coefficients

Table 1 an overview of the target countries

country	sign	GDP(Bil$)	GNI percap$	Export %GDP
China	CH	1176	960	25
Hong Kong	HK	163	24690	141
Indonesia	IN	141	710	42
Japan	JP	4178	34010	10
Korea	KR	427	9930	42
Malaysia	ML	88	3540	115
Philippines	PH	72	1030	49
Singapore	SG	85	20590	192
Thailand	TH	116	2000	66
Taiwan	TW	282	12600	57
The US	US	10020	35400	10

(*) value at 2001 (World Bank (2004) *Little Data Book*)

other area codes : WD...world, RW...the rest of the world

(2) Structural Equations

1) Definition of GDP

GDP=C+IF+GC+X-M

GDPV=CV+IFV+GCV+XV-MV

C....real private consumption

IF....real private investment

GC....real governmental expenditure

X....real exports of goods and services

M....real imports of goods and services

2) Private Consumption

The consumption function is basically specified under the Life Cycle and Permanent Income hypothesis. Consumers are assumed to behave to maximize there future income or utilities over a lifetime. This type of specification is taken kindly to utilizing forward looking variables in the sense which forecasts on the future income should affect the consumption today.

Now, we define the budget constraint as following;

$$W_{t+1}=(1-tr)\,Y_t-C_t+(1+r)\,W_t$$

W....asset

Y....yields

tr....tax rate

r....rate of return

The consumption which maximize the utility is defined as the equation bellow.

$$C_t=\left[\frac{\delta}{1+\delta}\right]E\left\{\sum_{i=0}^{\infty}\left[\frac{1}{1+\delta}\right]^{i}(1-tr)\,Y_{t+i}+W_t\right\}$$
$$=\theta(H_t+W_t)$$

δ....discount rate

Here, discounted series of future income H_t is called human capital (MULTIMOD, Ban model) and W_t is called non human capital. Let H_t be

$$H_t=\sum_{i=0}^{\infty}\left[\frac{1}{1+\delta}\right]^{i}(1-tr)\,Y_{t+i}$$

as the permanent income in a narrow sense Y^p. We ignore the non human capital here. Substitute this relation by staggering forward recursively, we finally obtain the following recursive equation.

$$Y_t^p=(1-tr)\,Y_t+\frac{1}{1+\delta}Y_{t+1}^p$$

As is well known, the consumption function is

$$C_t = \theta Y_t^p .$$

We take Y_t as the real disposable income, and bank deposit A(+1) as a proxy of the future income. Then, we have the equation to be estimated.

$$\begin{cases} C_t = c_0 + c_1 \dfrac{Yd_t}{PC_t} + c_2 \dfrac{1}{1+\delta} \dfrac{A_{t+1}}{PC_{t+1}} \\ A_{t+1} = Yd_t - CV_t + A_t \end{cases}$$

Yd....disposable income
PC....deflator for the private consumption
A....bank deposit

The equation used in reality is ;

C=C(11)+C(12)*PEDYV/PC*100
+C(13)*(1/(1+RLG(+1)/100))*DPRIV(+1)/PC(+1)*100

PEDYV....household disposable income
DPRIV....household deposit account
PC....deflator for the private consumption
RLG....long term interest rate(a proxy of the discount rate)

3) Disposable income

As the series of private disposable income are usually not available in the most Asian countries, in this paper, data are provided from OEF estimates, which are calculated basically using the average wage multiplied by the number of employee. However, the model can not well pursuit the dynamic fluctuation when adopting the path where the income is estimated through the wage because it does not reflect the GDP changes instantly. We adopted a simple formulation for the disposable income as a function of nominal GDP. Tax rate in the equation is overall rate of tax which includes income tax, indirect tax and corporate tax possibly, in several countries, they are not separable though.

PEDYV=C(1)+C(2)*(1-TAXRATE)*GDPV +C(3)*PEDYV(-1)

TAXRATE....overall rate of tax

4) Private investment

Investment functions are quite different depending on which country is taken up. In many developing countries the foreign capital inflow such as FDI has the decisive role in investments. The ratio of FDI to the total investment amounts to 30-40% in Singapore and Hong Kong, and about 10% in China. In some country, domestic investment is regularly parallel to FDI. Availability of the foreign capital is one of the important explanatory variables of investment. Capital fright from Indonesia which has not ended yet completely since the Asian financial crisis in1997 caused the long and severe recession and refrain of investment ever since because that the debt in dollar has become to the big amount of liability in terms of local currency unit according to the rapid depreciation in exchange rate and increase in the capital cost. In another country, FDI can crowd out the domestic investment.

Investment function used here is as following, which is for China, Hong Kong, Indonesia, Malaysia, Philippines, Singapore and Thailand excepting countries where the percent of foreign capital is rather small, or developed counties.

IF=C(1)+C(2)*GDP+C(3)*(NFDI$+FDI$)*RXD/PIF*100+C(4)
*TDEBT$*RXD/PIF*100

FDI$....Foreign Direct Investment (inflow, US$)
NFDI$....capital inflow excluding FDI
TDEBT$....foreign liability
RXD....exchange rate
PIF....deflator for private investment

Whereas, specification of the investment functions for the developed countries such as the US, Japan, Korea and Taiwan is rather conventional as is shown below.

IF/K(-1)=C(1)+C(2)*(GDP-X+M)/K(-1)+C(3)*IF(-1)/K(-1)
K=C(4)*K(-1)+IF

K.....capital stock (OEF estimates)

5) Export of goods and services

Trade model accounts for the largest part in our model, and consists of 11*11-11 (countries and area) bilateral trade functions. In this paper, we adopted the export function first instead of the import function though both type of approach can be applicable. Trade between exporting country and partner country is basically the function of demand of the partner (real GDP) and relative price of the exporting country to the partner country. Total export of each country is the summation of a row of the trade matrix, and total import is also the summation of a column of the matrix/

If we adopt the import function instead of the export function, the trade between two countries can be explained by the GDP of own country and the relative price. Stability of the function differs depending on the combination of the countries. Though the export function is not necessarily valid, here, we unified into the export function for the simplicity.

Export from China to Japan, for example, (XX_CHJP$) is ;

LOG(XX_CHJP$)=C(11)+C(12)*LOG(JP_GDP)+C(13)*
LOG(CH_PX$/(JP_PM/JP_RXD))+C(14)*LOG(XX_CHJP$(-1))

Total export of China (XX_CHWD$) comes to the summation of the row of matrix.

XX_CHWD$=XX_CHHK$+XX_CHIN$+XX_CHJP$+XX_CHKR$

		China		Japan		Total
		::				
China	···	-	···	XX_CHJP	···	X(export)
		::				
Japan		XX_JPCH		-		
		::				
Total		M(Import)				

+XX_CHML$+XX_CHPH$+XX_CHSG$+XX_CHTH$
+XX_CHTW$+XX_CHUS$+XX_CHRW$)

The transformation to the SNA accounts;

CH_X$=C(1)+C(2)*XX_CHWD$+C(3)*CH_X$(-1)
CH_X$V=CH_X$*CH_PX$/100
CH_XV=CH_X$V*CH_RXD
CH_X=CH_XV/CH_PX*100

X....real export in SNA
PX$....export price index in dollar
PM....import price index in local currency unit
RXD....exchange rate

6) Import of goods and services

On the other hand, import of goods and services is defined as the summation of a column of the trade matrix. The example regarding China is;

XX_WDCH$=XX_HKCH$+XX_INCH$+XX_JPCH$+XX_KRCH$
+XX_MLCH$
+XX_PHCH$+XX_SGCH$+XX_THCH$+XX_TWCH$+XX_USCH$
+XX_RWCH$)

Transformation to the SNA accounts;

CH_M$=C(1)+C(2)*XX_WDCH$+C(3)*CH_M$(-1)
CH_M$V=CH_M$*CH_PM$/100
CH_MV=CH_M$V*CH_RXD
CH_M=CH_MV/PM*100

M....real import in SNA
PX$....import price index in dollar
PM....import price index in local currency unite
RXD....exchange rate

7) Current account and capital account

BCU$=X$V—M$V
BCAP$=FDI$ + NFDI$

BCU$....current account in dollar
BCAP$....capital account
FDI$....FDI (inflow)
NFDI$....non FDI

8) Foreign reserves

Foreign reserves seem to be sometimes neglected and not to be handled explicitly in econometric models. However, it is clear that foreign reserves have much to do with intervention in a foreign exchange market and increase or decrease in foreign liabilities and domestic money supply as well.

Generally intervention in a foreign exchange market is regarded as to be less effective, because there might be no unlimited intervention and in addition, the reserve position tends to be considered not to have connected with the domestic money supply control owing to sterilization of the excess money.

However, it is not necessarily so in Asian nations. The increase and decrease of foreign reserves closely relate to the increase and decrease of the supply of money (monetary base). When sterilization is not performed, selling of the home currency (setback of foreign reserves) causes an increase of a monetary base of this amount. It may cause a drastic inflation and the currency "discount", though this is usually absorbed by the extra issuance of bonds by open market operations. For example, key variables in Thai economy during 1996-1998 show that the supply of money increased 1.29 times, and foreign reserves are 0.70 times diminishing, and Thai baht was depreciated to 1.63 times , and the government bond balance increased 2.54 times at the same time.

RES$=RES$(-1)+BCU$+BCAP$+RESPOS$

RES$....foreign reserves
BCU$....current account
BCAP$....capital account
RESPOS$....policy variable (generally set to zero)

9) Rate of interest

Due to the availability of data, rate of interest is limited to classify into two types, the long-term interest rate (savings interest rate and government bond yield for six months or more, etc.) and short-term interest rates. The short-term interest rate is determined by the money supply and the GDP under the conventional LM framework.

RSH=C(1)+C(2)*(MON2/PGDP)+C(3)*GDP

RSH....short-term interest rate
MON2....money supply(M2)
PGDP....GDP deflator

On the other hand, the long-term interest rate is formulated as a function of expectation of the short-term interest rate and a function of the rate of increase in amount of issued bond.

RLG=C(1)+C(2)*RSH(+1)+C(3)*(DBT/DBT(-1)-1)*100

RLG....long term interest rate
DBT....government debt stock

10) Money supply

The money supply is often treated as a exogenous variable in the econometric model. However, it is required to analyze the money supply connecting with the external asset and the control of exchange market. The money supply is treated exogenous when sterilization works, or else, it is assumed to be a function of foreign currency reserves and the government bond. The basic relation between foreign assets and the money supply is as following;

$\Delta DC = -\alpha \Delta FA$

DC....domestic credit
FA....foreign assets
α....rate of sterilization

Formulation in reality is,

d(MON2)=C(1)+C(2)*(1-delta)*(d(RES$*RXD))+C(3)*d(DBT)) + POLICY

POLICY....policy variable(exogenous, regularly set to zero)
delta....rate of sterilization(exogenous, if equals to 1, independent to reserves)
d() denotes the time difference

11) Prices

Price indices dealt in this model are the export price index PX, PX$, the import price index PM, PM$, the deflator for the private consumption PC, the deflator for private investment PIF, the GDP deflator PGDP. Among these, export and import price indices are consistent with the trade model. Though trade equations are estimated in terms of bilateral real trade, the relation in the real term stands in the nominal term. Therefore, an import price index of some country is defined as a combination or a weighted average of export price indices of partner counties.

Here, the export price (in local currency unit) is treated as exogenous, and does not vary by the partner countries. Within a free trade area such as ASEAN FTA, it can be different due to the differential duties.

The export price index is;

PX$=PX/RXD

PX....export price index (local currency unit)
PM....import price index (local currency unit)
$....if attached, it is denoted in dollar.
RXD....exchange rate

Whereas, the import price index is formulated as the weighted average of export price indices.

```
LOG(PM$)=C(1)+C(2)*((XX_HKCH$*LOG(HK_PX$)
        +XX_INCH$*LOG(IN_PX$)+XX_JPCH$*LOG(JP_PX$)
        +XX_KRCH$*LOG(KR_PX$)+XX_MLCH$*LOG(ML_PX$)
        +XX_PHCH$*LOG(PH_PX$)+XX_SGCH$*LOG(SG_PX$)
        +XX_THCH$*LOG(TH_PX$)+XX_TWCH$*LOG(TW_PX$)
        +XX_USCH$*LOG(US_PX$)+XX_RWCH$*LOG(RW_P$))
        /(XX_WDCH$)) + C(3)*LOG(PM$(-1))
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XXij$....bilateral trade (between i-j countries)

PM=PM$*RXD

Both deflators for consumption and investment are simple as are shown below. In some equation, parameters are summed up to unit so that the price elasticity does not exceed 1. GDP deflator is calculated implicitly using GDP and GDPV.

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LOG(PC)=C(11)+C(12)*LOG(ER)+C(13)*LOG(PM)
LOG(PIF)=C(21)+C(22)*LOG(ER)+C(23)*LOG(PM)
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PC....deflator for the private consumption
PIF....deflator for the private investment
ER....average wage index (OEF estimates)
PM....import price index

12) Employee and unemployment

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LOG(ET)=C(1)+C(2)*LOG(GDP)
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ET....number of employee

U=LS - ET

LS....labor force

U....number of unemployment

UP=U/LS*100

UP....unemployment rate

13) Wages

LOG(ER)=C(1)+C(2)*LOG(PGDP)+C(3)*LOG(ER(-1))

14) Nominal-real conversion

CV=C*PC/100

IFV=IF*PIF/100

GCV=GC*PGC/100

PGDP=GDPV/GDP*100 (implicit deflator)

(3) Solving the model

The solution for the forward looking model is different from a usual final test, which uses the iterative method by Fair-Taylor, and adopts Newton method instead of conventional Gauss-Seidel method which does not converge fast. As to China, Japan, Korea, Taiwan and the US, the results are almost acceptable, however, the model could not follow the deep slowdown in 1998 just after the East Asian financial crisis. Especially, Singapore model and others, for example, have some rooms to improve the accuracy.

(4) Anticipated and unanticipated shocks

A decisive difference between the forward looking model and the conventional model is that the former can treat the effects in advance which can be occurred in the future by policy changes if anticipated. If people know what will occur in the future, then they prepare for it and want to adjust there behaviors.

We quote again the recursive equation in which endogenous variables are developed in the series of future exogenous variables.

$$y_t = \gamma\beta^{n-1}x^*_{t+n-1} + \cdots + \gamma\beta x^*_{t+1} + \gamma x_t + \eta_t$$

Assume 2-year lead time, for example, the increment in $y_t(\Delta y_t)$ caused by the policy change Δx_t is denoted as following. If the policy change could be anticipated, changes will realize 2 periods later from the present position (t), and the time will pass 1 period (t+1), then changes will realize 1 period later, so on.

$$\Delta y_t = \gamma \sum_{i=2}^{n} \beta^i \Delta x_{t+1}$$

$$\Delta y_{t+1} = \gamma \sum_{i=1}^{n-1} \beta^i \Delta x_{t+i+1}$$

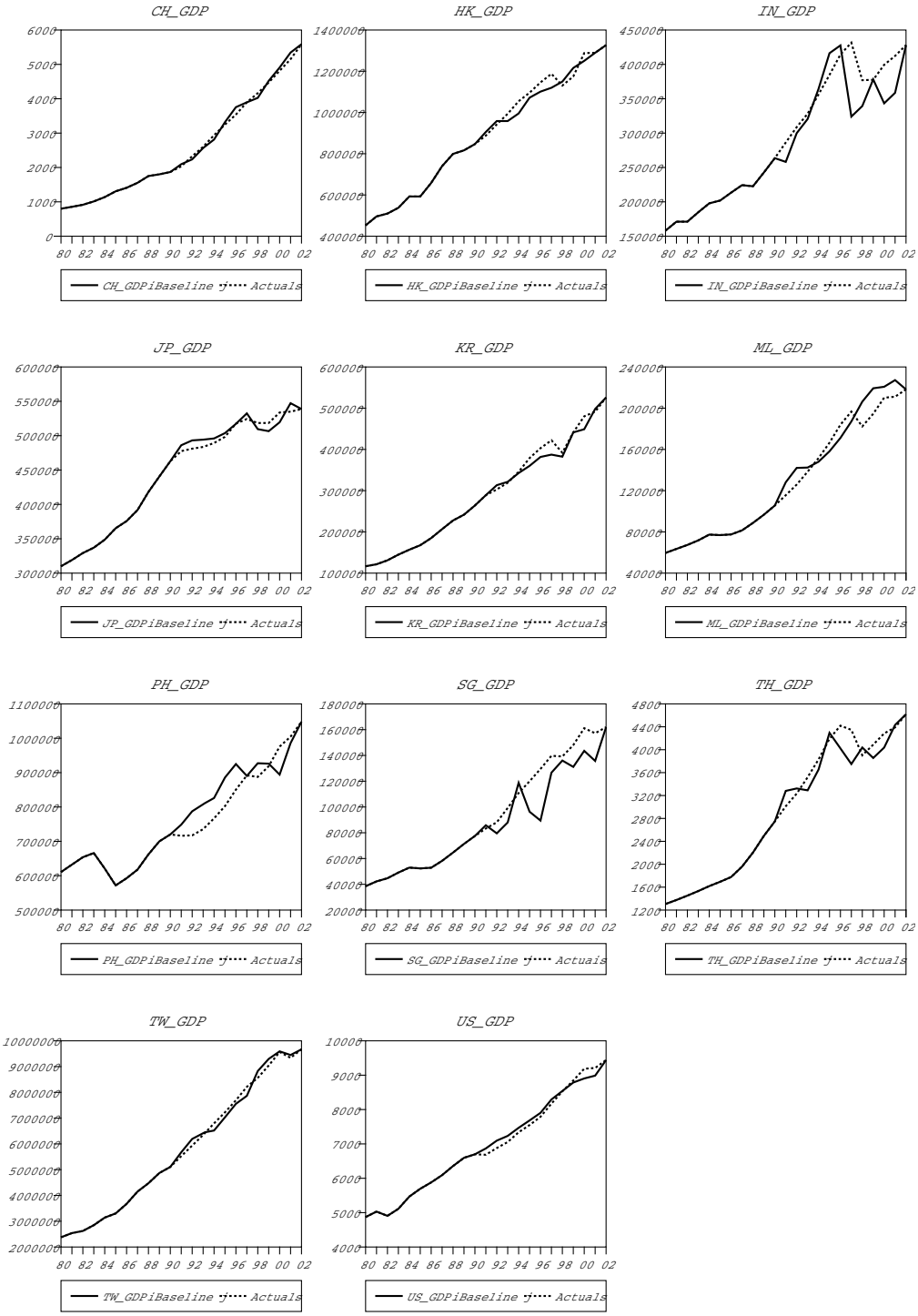


Fig.1 Results in final tests for GDP

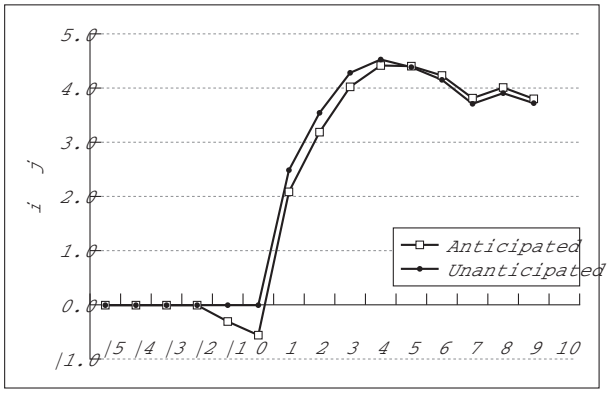


Fig. 2 Anticipated and unanticipated simulation

$$\Delta y_{t+2}=\gamma\sum_{i=0}^{n-2}\beta^{i}\Delta x_{t+2}$$

On the other hand, increments in period (t) and (t+1) will be $\Delta y_t=\Delta y_{t+1}=0$ if unanticipated. This becomes different in case of anticipated and unanticipated simulation respect to the forward looking model. When constant changes $\Delta x_t=\Delta x$ are carried and the economy continues to glow, in general, effects will tend to diminish. Therefore, it is commonly observed that the anticipated case is less effective than the unanticipated case. If people anticipate a policy change, effects will be suppressed, however it depends on the model and parameters. The figure below shows the difference in the effect of Japanese fiscal expansion.

4. Simulation analysis

(1) Changes in exchange regime

Yen was appreciated largely from 235 yen/dollar to 94 in the short time since the Plaza agreement in 1985. Japanese government tried to correct the excessive rise in yen and made intervention in a large scale in the foreign exchange market and led interest rates low, in addition, strengthen its credit-ease stance. This caused the bubble economy. Since 1995, exchange rate of yen has been kept rather stable, but, it is possible to be appreciated again due to the recovery of the economy.

On the other hand, China has already adjusted to depreciate yuan from 5.7 to 8.6 in 1994, since maintained dollar-peg system practically. As the Chinese economy glows, yuan is becoming to be exposed by the pressure to appreciate these days. Though ASEAN countries have also maintained dollar-peg system, those schemes are confronting to reorganization since 1997.

In this paper, we examined 3 cases concerning the exchange regime.

Fig. 3 Yen and Yuan

Table 2 Major results of the simulation

		China	Japan	Korea	Taiwan	US	ASEAN+China	
yen 10%UP	GDP	0.18 (1.09)	-1.50 (-1.33)	0.11 (0.79)	0.55 (0.29)	0.31 (0.14)	0.51	($)
	Export	0.55	-5.87	1.20	1.62	0.68		
	Import	-0.51	-1.54	-1.0	-1.00	-1.14		
	Regional Trade						2.25	($)
yuan 10%UP	GDP	-2.80 (-2.91)	0.44 (0.02)	0.22 (0.11)	0.37 (0.01)	0.18 (0.00)	0.61	($)
	Export	-8.51	0.49	0.65	0.80	0.47		
	Import	-1.77	-1.52	0.21	0.33	-0.17		
	Regional Trade						0.56	($)
dollar 10% DOWN	GDP	-1.40	-1.0	-4.70	-1.38	2.20	-1.62	($)
	Export	-3.05	-3.91	-4.04	-2.24	2.94		
	Import	-1.59	-0.92	-1.94	-0.72	-1.82		
	GDP	-1.40	-1.0	-4.70	-1.38	2.20	-2.86	($)

① 10% appreciation of yen
② 10% appreciation of yuan
③ 10% depreciation of dollar

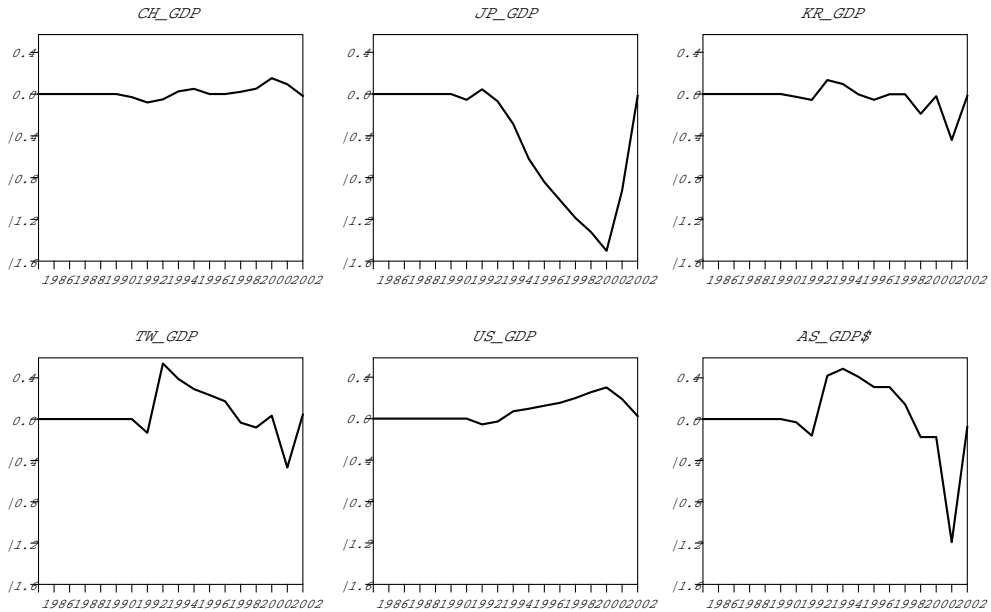
It is presumed that real GDP of Japan decreases by about -1.5% when yen increases by 10%. Moreover, the effect on the investment is larger than that of consumption, and it decreases by -2.4%. Export of Japan will be affected strongly, decrease by -6.0%. On the contrary, import increase a little for a while, then will decrease according to the decline in GDP. This is presumed to be 1.0%. Slowdown of Japanese economy

will make the other countries active, GDP of China will increase by +0.18%, +0.31% in the US economy. Besides this, the influence on Taiwan and ASEAN nations is comparatively large. Trade (nominal value in dollar, the sum of exports and imports) of 6 countries including ASEAN countries and China will grow by +2.3% due to the decrease in Japanese export. The regional trade within these 6 countries also increase greatly by +6.0%.

Our estimate of effects on GDP of Japan is almost the same as the percent estimated by the Japanese Cabinet (2002) which shows -1.3% decrease. Our results also show rather small influence on Chinese economy and have larger influence on the US economy when compared to the Cabinet model.

Similarly the simulation on the Chinese economy in which yuan is appreciated by 10% suggests that GDP will slow by -2.8%, that is, at the first stage, J-curve effect is largely observed then will decrease as the time passes. Especially export oriented country such as China has the large influence on exports compared to the developed country like Japan. Effects on Japanese GDP is presumed to become +0.44%. This estimate is a little larger than the estimate of Cabinet model.

Next, we test the influence of the depreciation of dollar by 10%, this causes +2.2% rise in the US GDP, and decline of GDPs of all other nations, for example, it leads -1.0% decline in Japanese GDP and -1.4% in China, which are greater than the impact on other Asian countries.



(*) AS_GDP$ denotes total real GDP in dollar of ASEAN countries.

Fig. 4 Effects on GDPs by the appreciation of yen

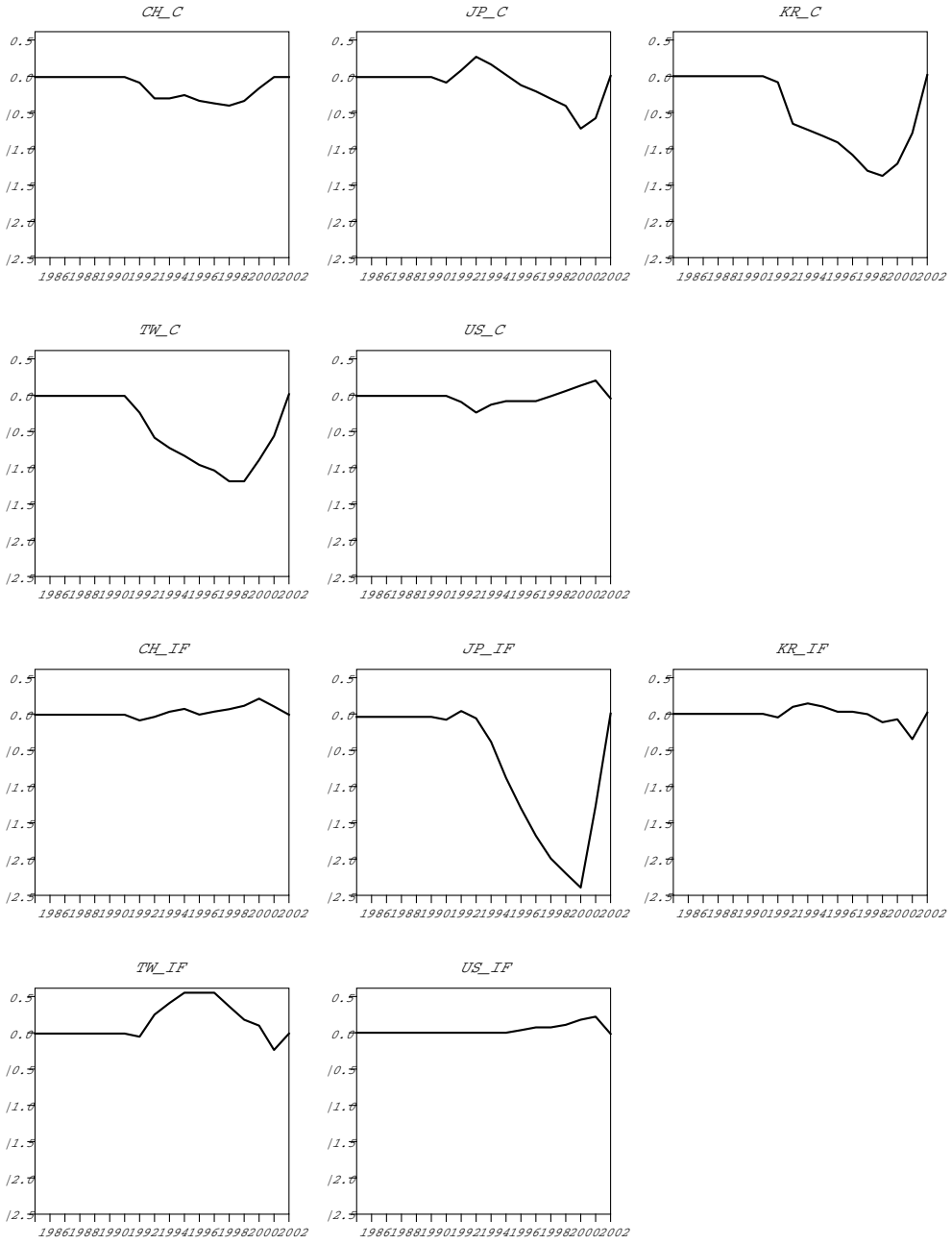


Fig. 5 Effects on domestic demands by the appreciation of yen

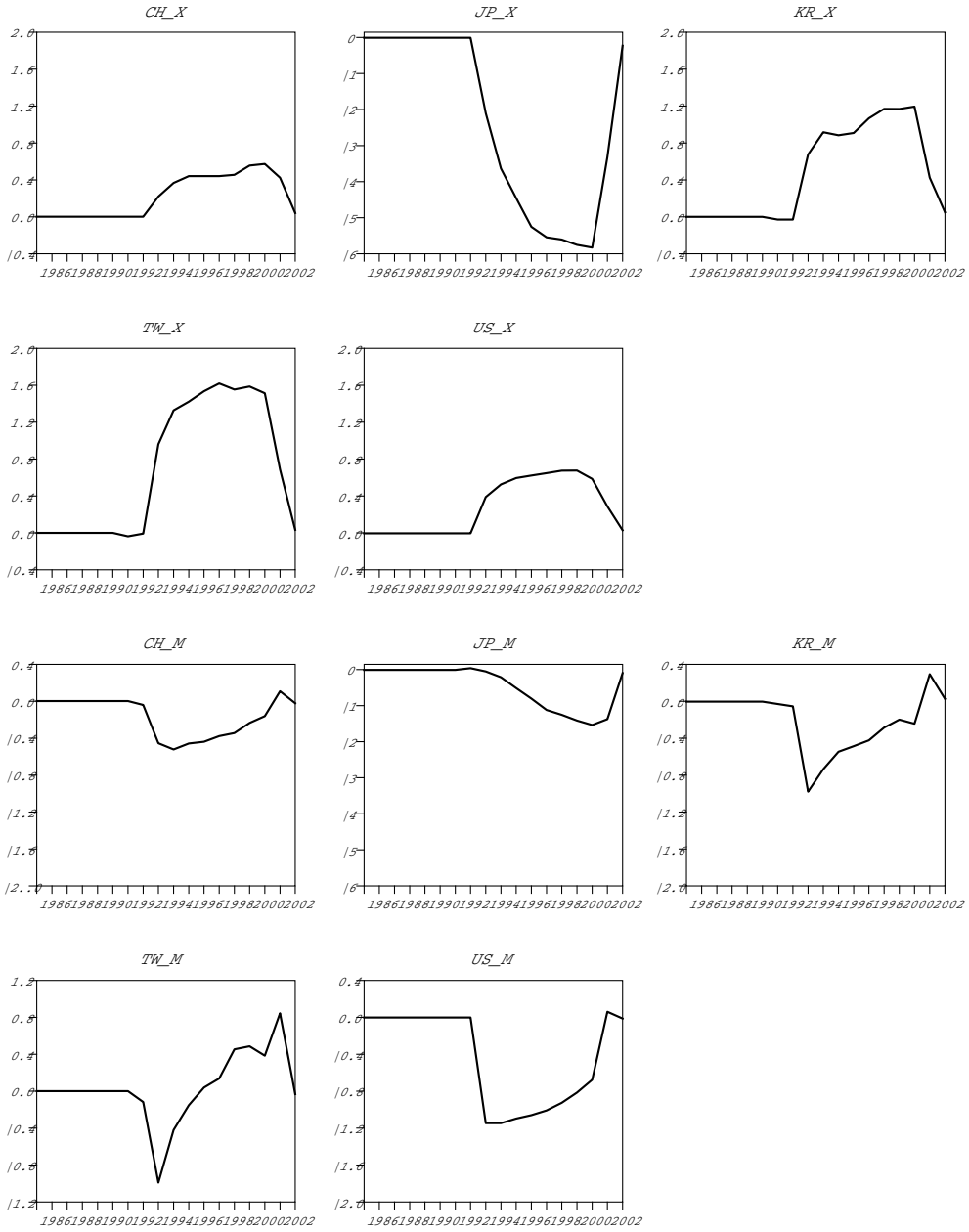
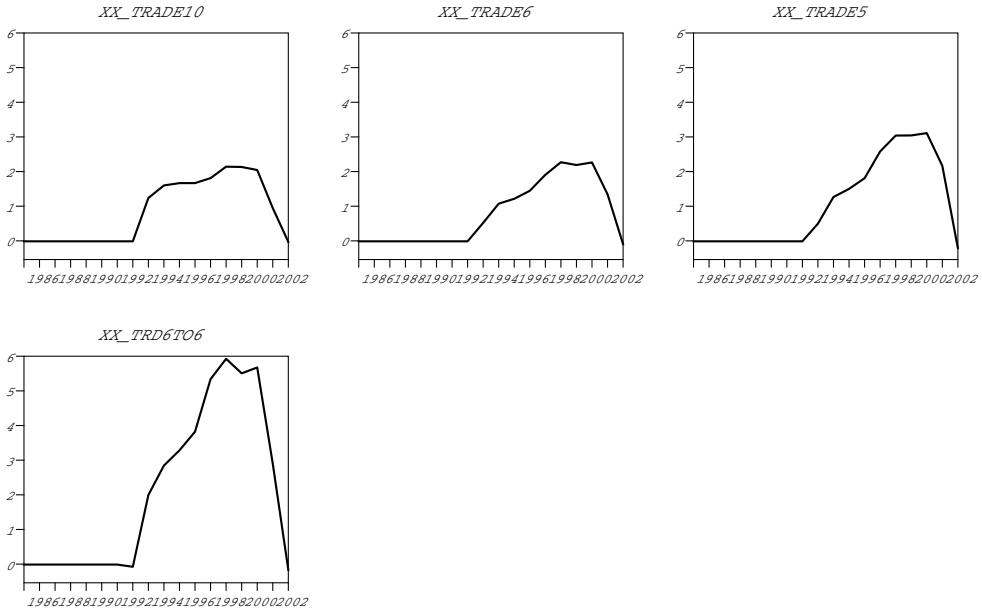
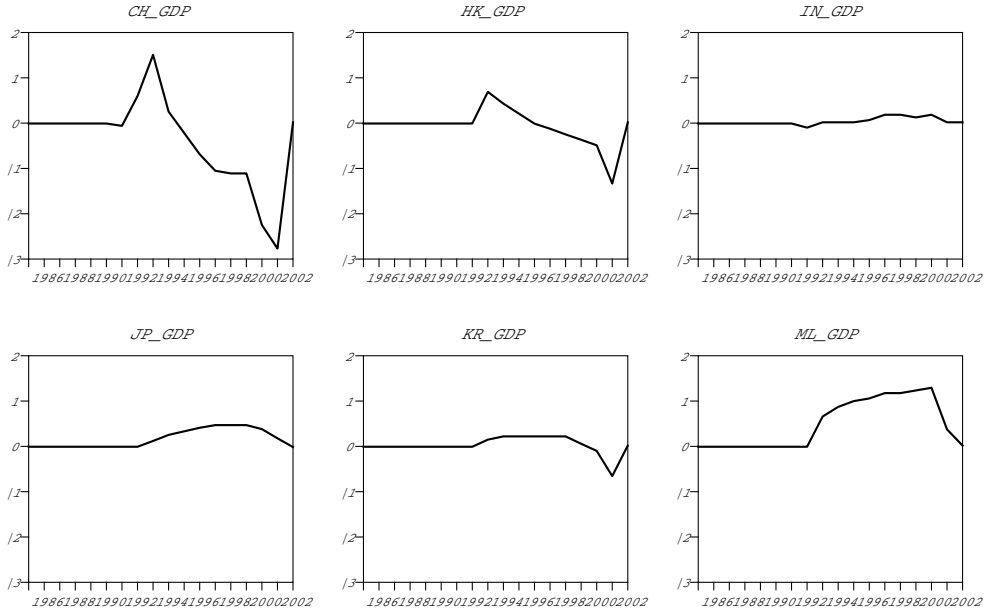


Fig. 6 Effects on exports/imports by the appreciation of yen



(*) XX_TRADE is the sum of exports and imports
10 means Asian countries quoted above including Japan
6 means ASEAN 5 countries and China
5 means ASEAN 5 countries
XX_TRD6TO6 is the regional trade within ASEAN plus China

Fig. 7 Effects on Asian trades by the appreciation of yen



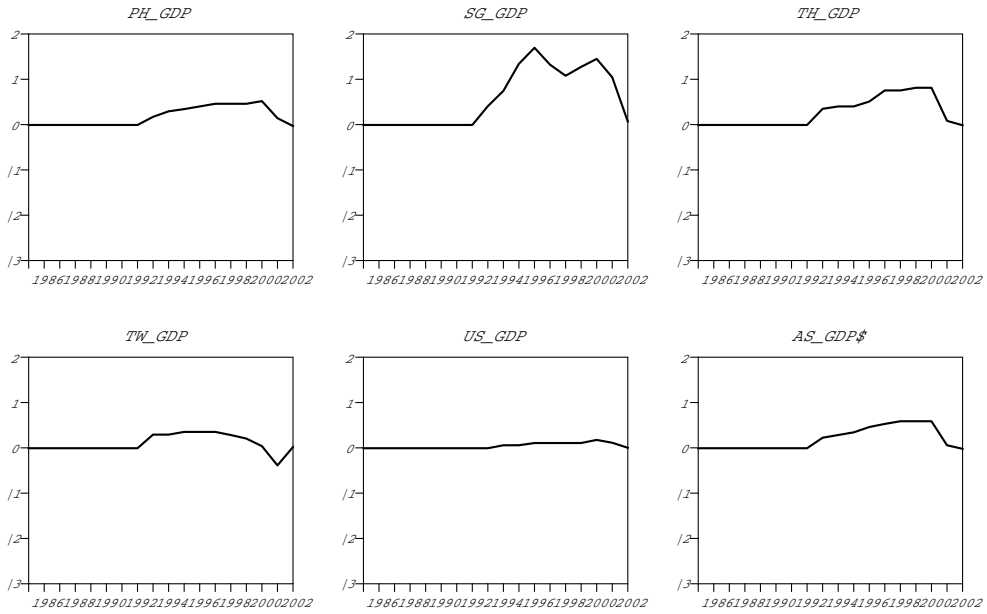
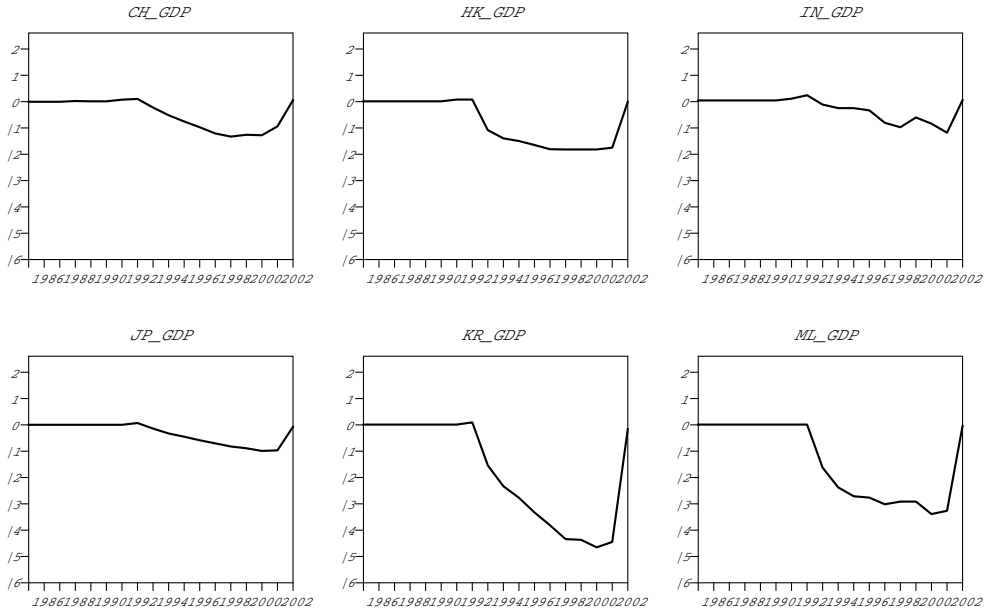


Fig. 8 Effects on GDPs by the appreciation of yuan



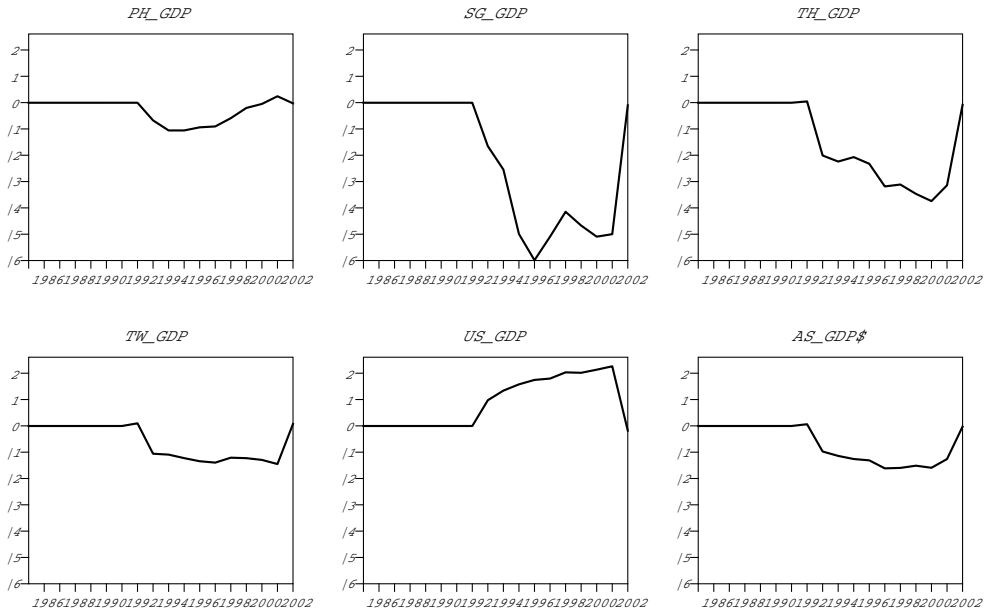


Fig. 9 Effects on GDPs by the depreciation of dollar

(2) Effects of FTA between ASEAN and China

Inclusive agreements on trade in WTO have made slow progress in recent years, parallel to WTO, new international movements that two or several countries make a treaty on bilateral trade to reduce tariff and promote deregulation on the trade have arisen actively since 2000. Especially Singapore and Thailand have promoted this movement, and concluded the treaty such as ASEAN FTA (Free Trade Agreement). JETRO estimates that those kind of treaty accounts for 107 in the world, however, it reaches merely 14 in Asia pacific region. But the tendency seems to become the main stream soon in the future.

So far, there was no such a important agreement in Asian area except ASEAN FTA, however, ASEAN countries and China are going to conclude a new FTA on the background of the rapid increase in Chinese economy, and in 2002, an inclusive agreement of economic cooperation was made between ASEAN and China.

Though FTA usually has the wide variety of options such as early harvest or full abolition of tariff, we carried the case of 5% reduction of the tariff in the bilateral trade, which is quoted in AFTA plan in World Bank(2003) and Kimura(2002). That is a case that the exporting price of ASEAN countries and China is reduced by 5% if the partner country is one of those countries and the other partner countries remain having not discounted prices.

In this model, changes in relative price will occur only in the trade between countries within ASEAN and China. However, as the export price of some concerned country will change by the 5% reduction, this affects slightly to the relative price of another country involved.

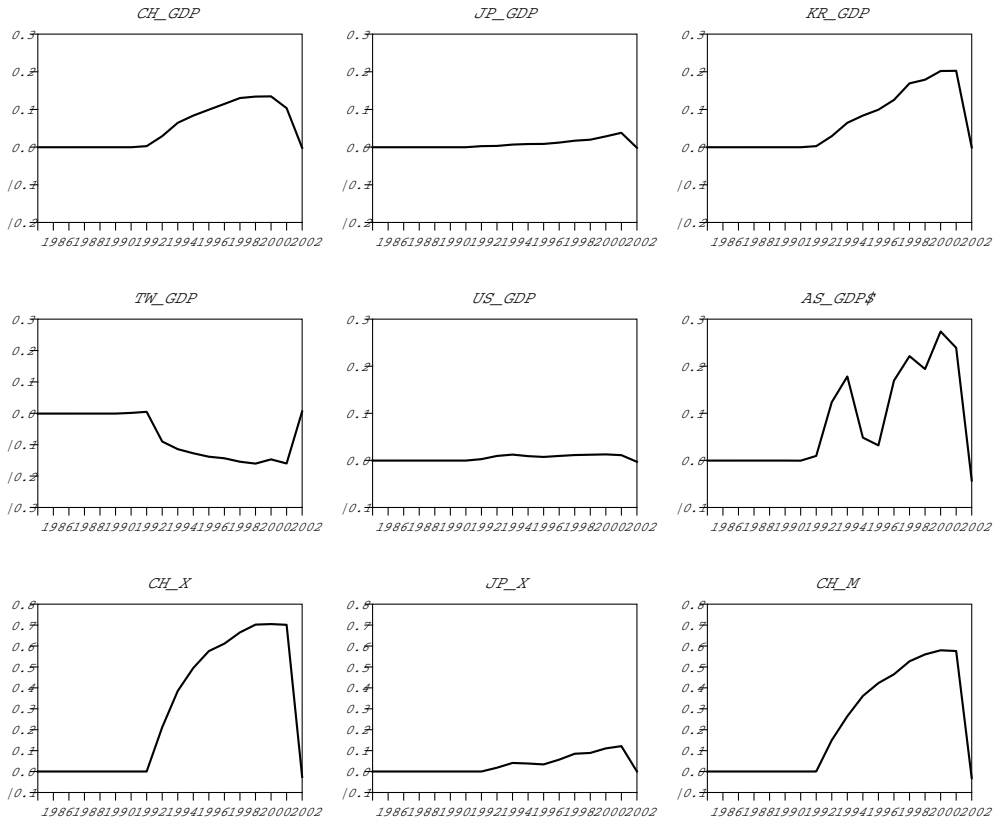
Table 3 FTA and major effects

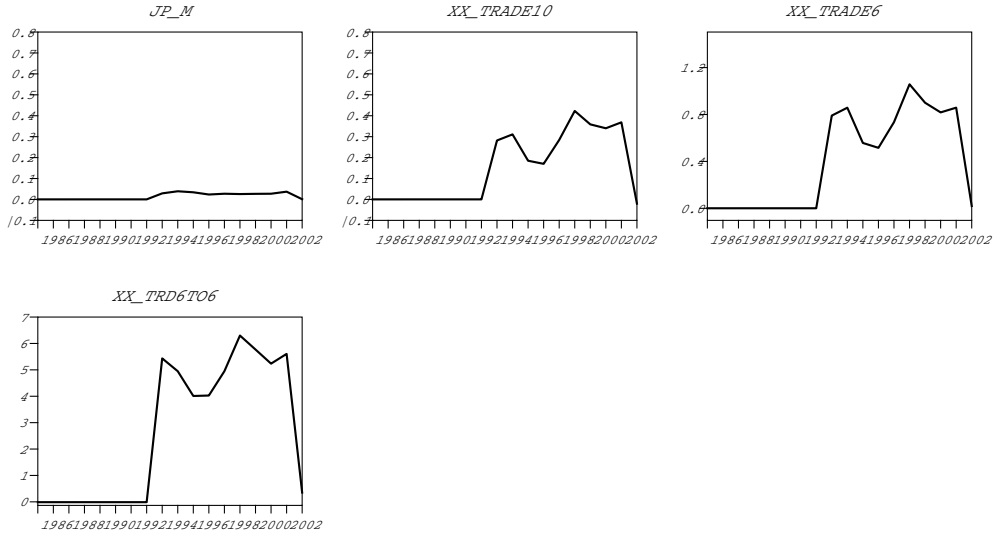
		China	Japan	Korea	Taiwan	US	ASEAn+China	
ASEAn +China FTA	GDP	0.14	0.03	0.29	-0.16	0.01	0.27	($)
	Export	0.17	0.13	0.17	-0.06	-0.03		
	Import	0.58	0.04	0.18	0.15	0.04		
	RegionalTrade						1.05	($)
	Intra rade						6.32	($)

(*) Regional trade means the sum of exports and imports of ASEAN and China Intra trade means the trade within those countries

Simulation results suggest that FTA has a gain in GDP of China by +0.14% and ASEAN by +0.27%, whereas, FTA does not have large effects on Japan and the US. Effects vary by the country, for example, the influence on Korean GDP is +0.2%, on the contrary, -0.16% on Taiwanese GDP.

Trade of these countries increases by +1.0%, and the intra trade of this region goes up to +6.3%, nevertheless, amount of the trade remained still small and FTA does not have necessarily decisive roll in this area yet.





(*) Trade 10 include concerned 10 countries. see page xxx.

Fig. 10 FTA and its effects

(3) FDI increase in China

FDI inflow of China grows rapidly and contributes to the economic growth and strengthens the basis of technological development. The ratio of FDI to the domestic investment is almost 10%. In the model, as we formulated the investment function by using FDI and non-FDI capital inflow, the simulation that is similar to the fiscal expansion can be performed.

FDI is considered to tighten trade relations with the partner countries through technology transfer, sales chain of final products and supply chain of raw materials

Table 4 FDI in China

Country	1985	1990	1995	2000	2001	2002	2003
World	1956	3487	3721	40715	46878	52743	53505
Japan	315	503	3108	2916	4348	4190	5054
Hong Kong	n.a.	1880	20060	15500	16717	17861	17700
Korea	n.a.	n.a.	1043	1490	2152	2721	4489
Taiwan	n.a.	n.a.	3162	2296	2980	3971	3377
Singapore	10	50	1851	2172	2144	2337	2058
US	357	456	3083	4384	4433	5424	4199
EU(15)	n.a.	n.a.	n.a.	n.a.	4183	3710	3930
Cayman islands	n.a.	n.a.	12	624	1067	1180	866
Vergine islands	n.a.	n.a.	304	3833	5042	6117	5777

Unit:million US dollar, quoted from Institute for International Trade and Investment

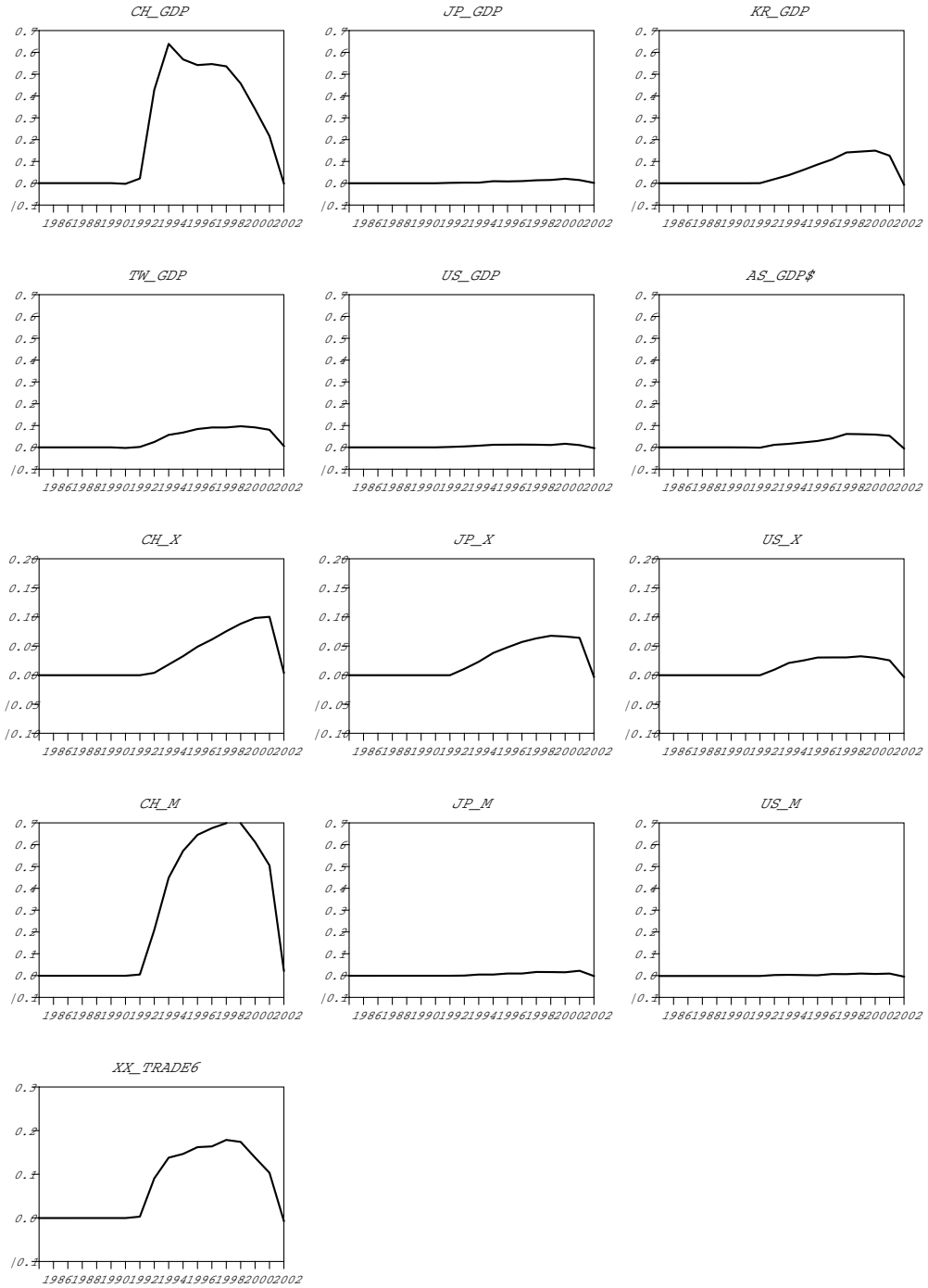


Fig. 11 Effects of FDI increase

and intermediate products. Although these indirect effects should be considered important, in this model, induction of FDI into bilateral export functions or total export/import functions can not be successfully done. Therefore, here, we just examine in a simple way the effect of 10% increase in FDI which is implemented in the investment function.

As a result, FDI expansion lead GDP growth by +0.55%, however it does not affect much the economy outside. Increase in import amounts to +0.72% on one hand, that of export remains very low (+0.09%) on the other hand. FDI has the import augmenting characteristics in China.

(4) Fiscal expansion

We examine the effects of fiscal expansion, which Japanese government expand public expenditures by 10% to the actual value. This causes +3.7% increase in real GDP and leads the import from the other countries where the economy expands as a result. For example, export from China to Japan shows +1.9% increase in GDP of China and in the same way, +1.6% increase in Korean GDP.

This effect is almost equivalent to 1.8 in terms of multiplier of the fiscal expansion, and a little smaller than the estimates by the Cabinet short-run model, in which it is estimated about 1.2 (Japanese Cabinet, Keiko Murata (2005)). The difference comes from the fact that the Cabinet model stressed on the fiscal balance, assumed that the fiscal expansion should result in the increase in tax rate which crowd out the income increase. Our model does not include those crowding mechanisms.

Same kind of simulation was performed for the Chinese economy. The real GDP of China increases by +2.9%, that is rather less effective than that of Japan and does

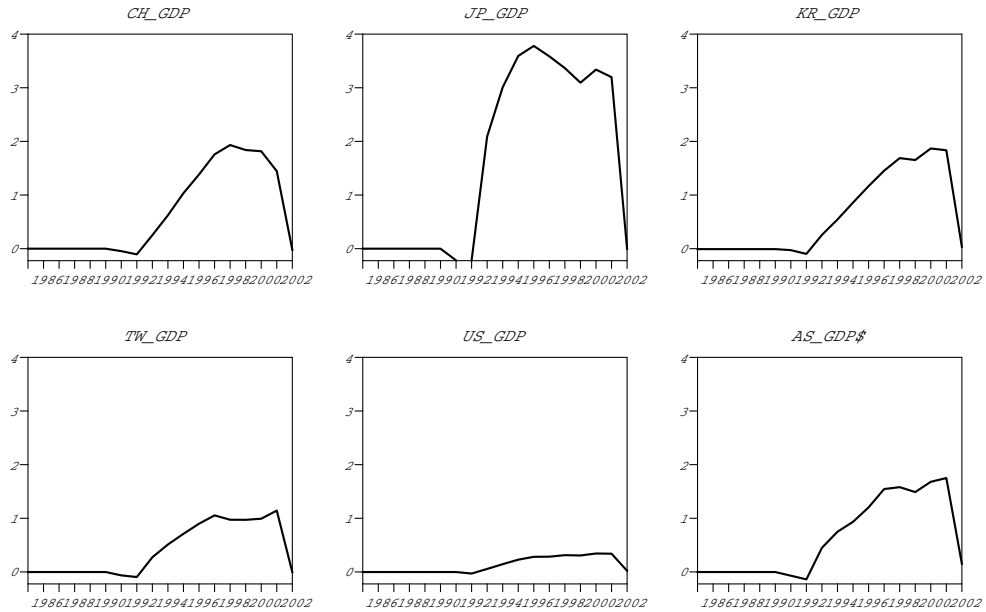


Fig. 12 Effects of the fiscal expansion in Japan

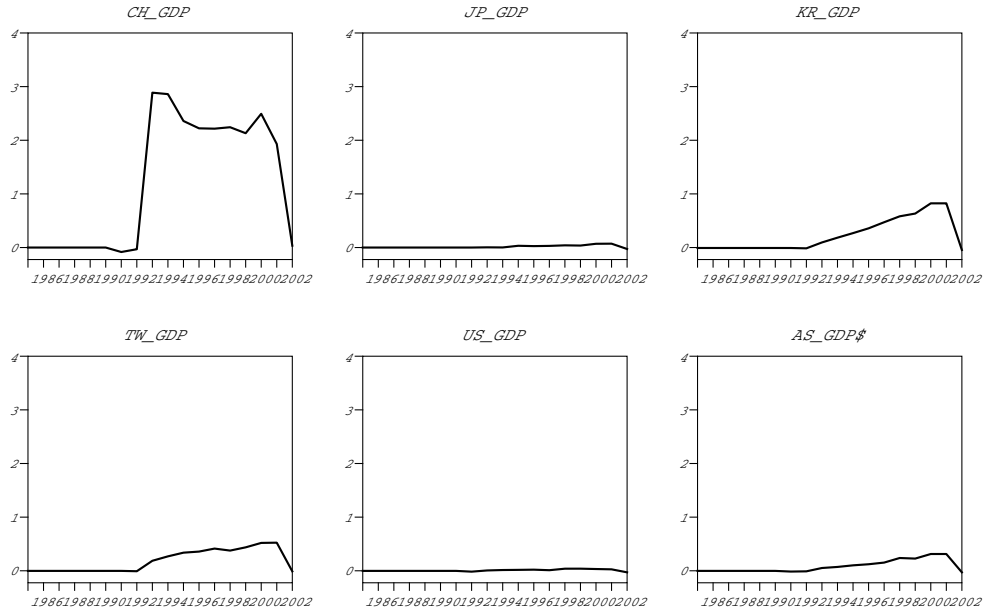


Fig. 13 Effects of the fiscal expansion in China

not have much effects on Japanese and the US economy, but less effects on Taiwan and Korea. Effects of China on Japan are asymmetrical to the effects of Japan on China.

5. Concluding remarks

In this paper we examined the several simulation analysis such as changes in the foreign exchange regime and FTA et. al. using the open macro econometric model with forward looking variables. In this study, it became clear that appreciation of yen will cause the large reduction of export and increase in expansion of Asian economies. Appreciation of yuan also leads expansion on the economy of other countries as well, however, China has much more effects on the Asian countries than Japan. According to the analysis of FTA, intra trade within ASEAN and China will grow greatly by concluding agreements. However, its effects remain rather small outside the area, and are limited. Fiscal expansion of Japan has a great influence on the other Asian countries, on the contrary, that of China tends to be restricted within China.

Several improvements may be needed, for example, FDI inflow and out flow OD table can be specified to some country models, which enables us to analyze another type of investment functions and export functions as well. Estimation of parameters especially involved in export functions must be careful, that affects very much the trade relations. Adding to the above, Tobin's Q theory can be applied to the investment function to induce the short term capital flows clearly as well as long term capital flow such as FDI.

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